MINISTERIO DE CIENCIA E INNOVACIÓN

Cofinanciado por la Unión Europea

AGENCIA ESTATAL DE INVESTIGACIÓN

CURRICULUM VITAE (CVA)

Part A. PERSONAL INFORMATION

CV date	17/12/2023

First name	Jacobo		
Family name	Aguirre Araujo		
Gender	Male	Birth date	25/08/1975
ID number	50861512W		
e-mail	jaguirre@cab.inta-csic.es	Web: http://complexityweb.com/aguirre	
Open Researcher and Contributor ID (ORCID)		0000-0003-2196-5103	

A.1. Current position

Position	Científico Titular CSIC		
Initial date	14/12/2023		
Institution	CSIC		
Department/Center	Dep. Evolución Molecular	Centro de Astrobiología (CSIC-INTA)	
Country	Spain	Teleph. number	(34)91 520 1692
Key words	Complexity, complex network theory, nonlinear dynamics, astrobiology, mathematical modelling of evolutionary processes, viral/RNA evolution.		

A.2. Previous positions

Period	Position/Institution/Country
01/10/1999-31/08/2004	Ayudante E.U., Univ. Rey Juan Carlos, Madrid, Spain.
01/09/2004-31/08/2006	Profesor ayudante-doctor, Univ. Rey Juan Carlos, Madrid, Spain.
01/09/2006 - 31/03/2008	Postdoctoral researcher (Asistencia técnica), Centro de Astrobiología CSIC-INTA, Madrid, Spain.
02/04/2008 - 01/04/2013	Postdoctoral researcher (Contrato para incorporar investigadores al sistema español de ciencia y tecnología), CAB (CSIC-INTA), Madrid, Spain.
05/04/2013 - 31/12/2013	Postdoctoral researcher, U. Carlos III de Madrid, Madrid, Spain.
01/01/2014 - 01/06/2014	Postdoctoral researcher, CAB (CSIC-INTA), Madrid, Spain.
01/06/2014 - 30/06/2016	Postdoctoral researcher, Centro Nacional de Biotecnología (CSIC), Madrid, Spain.
01/07/2016 - 30/06/2018	Postdoctoral researcher *Severo Ochoa*, CNB (CSIC), Spain.
01/08/2018 - 30/06/2019	Postdoctoral researcher CNB (CSIC), Madrid, Spain.
26/11/2019 - 31/05/2020	Postdoctoral researcher CAB (CSIC-INTA), Madrid, Spain.
16/10/2020 - 31/12/2020	Postdoctoral researcher CAB (CSIC-INTA), Madrid, Spain.
01/03/2021 - 13/12/2023	Distinguished Researcher CSIC, CAB (CSIC-INTA), Madrid, Spain.

A.3. Education

PhD, Licensed, Graduate	University/Country	Year
PhD in Physics	Universidad Rey Juan Carlos	2004
Graduate in Physics	Universidad Complutense de Madrid	1999

Part B. CV SUMMARY *(max. 5000 characters, including spaces)*

I graduated in Physics (Univ. Complutense de Madrid) in 1999 and I obtained my PhD at Universidad Rey Juan Carlos in 2004. In the period 1999-2006 I worked as a teacher assistant at U. Rey Juan Carlos. I enjoyed postdoctoral positions at Centro de Astrobiología (CAB), CSIC-INTA, (2006-2014) and Centro Nacional de Biotecnología (CSIC) (2014-2019). In 2020 I created the *Complexity and Astrobiology Group* at Centro de Astrobiología. In March 2021 I obtained there a permanent position (CSIC Distinguished Researcher), and in December 2023 I became Científico Titular CSIC. Currently my research group consists of a permanent researcher, a PhD student (Marina Fernández) and a CAM Ayudante de Investigación student (Carla Alejandre). I have carried out research stays in Germany, Denmark and the United States, and in 2005 I received the *National Prize for Young Researchers in Theoretical Physics*, awarded annually by the Spanish Royal Physics Society. I received a positive evaluation for *Profesor titular* of applied physics by ANECA in 2012 and the certificate of a distinguished research career by AEI (*Programa I3*) in 2018.

I have published around 60 scientific papers (more than 50 in indexed journals, first author in 30, last author in 9, 37 with 3 or fewer authors, 7 book chapters). Most of my work has been published in prestigious journals such as *Reviews of Modern Physics, Nature Physics, Nature Ecology & Evolution, Nature Communications (2), PNAS, Physics of Life Reviews, Phys. Rev. Lett. (3), Nucleic Acids Research, Phys. Rev. E (5), Nonlinearity, Phys. D (2), Environ. Microbiology*, etc. I have collaborated in around 20 research projects, three of them with European funding, being twice the PI. In addition, I have presented my research in about 40 conferences, 7 of them as an invited speaker at international conferences. I am the co-founder of the *Astronomical Group of the Universidad Rey Juan Carlos* (2001) and the technological company *Complexity Killed the Cat S.L.* (2013) through which I collaborate in the transfer of scientific knowledge based on complex networks to the private sector in the fields of health and education. Since 2015 I am an *invited lecturer* at a master on Biophysics at Universidad Autónoma de Madrid, and since 2001 I give a 30-hour course on Astronomy at Universidad de Mayores (URJC) and develop other outreach activities, often collaborating on science issues on TV, radio and in the press.

Regarding the management of research and academic tasks, I have evaluated projects for the *Plan Nacional de I+D+I* (ANEP, 2018, 2019, 2023), for the *Biotechnology and Biological Sciences Research Council* (BBSRC, UKRI, United Kingdom, 2022), for the *Agencia Nacional de Promoción Científica y Técnica* of Argentina (ANPCYT, 2016, 2018, 2021), and for the *Technology Identification and Development Department* of the *eGauss S.L.* business group (2016). I am reviewer of several prestigious journals (*Nature Communications, Nature Ecology & Evolution, eLife, Phys. Rev. Lett.,* etc.) Also, while I am currently supervising a PhD student and an "Ayudante de Investigación Garantía Juvenil CAM" student, I supervised in 2022 a postdoctoral researcher and an Erasmus+ student, and in the past I supervised 2 JAE Intro ICU CSIC (January-May 2021 and February-July 2023), 9 master's degree final projects (TFM) at UAM and 1 degree final project at URJC, and I have belonged to 7 PhD committees. Also, I have collaborated in the organization of more than ten scientific events in the last decade (see C.5 for more details).

My research work deals with the analysis and modelling of the evolution of complex physical and biological processes in the context of non-linear dynamics, complex networks and astrobiology. I have applied my results to other fields such as economics or social sciences.
In the field of physics I started studying the influence that fractal structures associated with initial conditions have on the evolution of non-linear systems and the control of such systems. In the last decade I have focused on the application of complex network theory to physical, social or technological processes. In the field of biology I am interested in the study of complex systems in the context of the origin and evolution of life. This research is carried out in close coordination with experimental researchers, emphasizing the biomedical applications of our work. Graph theory has been especially useful in this environment to model the genotype-phenotype relationship of organisms that replicate at high mutation rates (viruses, RNA sequences, etc.)
In parallel, in recent years I have become interested in the application of complexity theory to biotechnology, and in particular to the development of analytical techniques for environmental/health purposes. I have focused on the application of graph theory to antibody microarrays with the aim of

improving the characterization of experimental samples, with applications to the study of allergies, the detection of toxins and planetary sciences.
My interests in the coming years will focus on developing a new theoretical and methodological framework to apply the tools of non-linear dynamics and complex networks to the analysis of evolutionary processes of theoretical, astrobiological or biomedical interest for society.

Part C. RELEVANT MERITS *(sorted by typology)*

C.1. Publications (brief selection)

- M. Fernández-Ruz, I. Jiménez-Serra and **J. Aguirre**, *A theoretical approach to the complex chemical evolution of phosphorus in the interstellar medium*, Astrophysical Journal **956**, 47 (2023).
- P. Catalán, J.A. García-Martín, **J. Aguirre**, J.A. Cuesta, S. Manrubia, *Entropic contribution to phenotype fitness,* Phys. A: Math. Theor. **56**, 34560 (2023).
- **J. Aguirre** and R. Guantes, *Virus-host protein co-expression networks reveal temporal organization and strategies of viral infection*, iScience **26**, 108475 (2023).
- **J. Aguirre,** *Life finds a way*, Nature Ecology & Evolution, https://doi.org/10.1038/s41559-022-01877-x (2022). Invited paper. (Impact factor=15.46).
- M. García-Sánchez, I. Jiménez-Serra, F. Puente-Sánchez, **J. Aguirre,** *The emergence of interstellar molecular complexity explained by interacting networks*, PNAS 119 (30), e2119734119 (2022). (Impact factor=11.21). This work was recently highlighted by A. Rastogi in *Nature Computational Science 2, 470 (2022), Network science to study the origins of life.*
- S. Manrubia, J.A. Cuesta, **J. Aguirre** et al. (3/18), *From genotypes to organisms: State-of-the-art and perspectives of a cornerstone in evolutionary dynamics*, Physics of Life Reviews **38**, 55 (2021). (Impact factor=11.02).
- J.M.Buldú, D.R. Antequera**, J. Aguirre**, *The resumption of sports competitions after COVID-19 lockdown: the case of the Spanish football league*, Chaos, Solitons & Fractals **138**, 109964 (2020). (Impact factor=5.94).
- J.M. Buldú, F. Pablo-Martí, **J. Aguirre**, *Taming out-of-equilibrium dynamics on interconnected networks*, Nature Communications **10** (1), 5314 (2019). (Impact factor=12.12).
- **J. Aguirre**, P. Catalán, J.A. Cuesta and S. Manrubia, *On the networked architecture of genotype spaces and its critical effects on molecular evolution,* Open Biology **8** (7), 180069 (2018). (Impact factor=3.89).
- J. Iranzo, J.M. Buldú and **J. Aguirre**, *Competition among networks highlights the power of the weak*, Nature Communications **7**, 13273 (2016). (Impact factor=12.12).
- F. Puente-Sánchez, **J. Aguirre**, V. Parro, *A novel conceptual approach to read-filtering in high-throughput amplicon sequencing studies,* Nucleic Acids Research **44**, e40 (2016). (Impact factor=10.16).
- **J. Aguirre**, R. Sevilla-Escoboza, R. Gutiérrez, D. Papo and J.M. Buldú, *Synchronization of Interconnected Networks: The Role of Connector Nodes*, Phys. Rev. Lett. **112**, 24870 (2014). (Impact factor=7.73).
- **J. Aguirre**, D. Papo and J.M. Buldú, *Successful strategies for competing networks*, Nature Physics **9**, 230-234 (2013). (Impact factor=20.60).
- **J. Aguirre**, J.M. Buldú, M. Stich and S. C. Manrubia, *Topological structure of the space of phenotypes: The case of RNA neutral networks,* PLOS ONE **6**, e26324 (2011). (Impact factor=4.092).
- **J. Aguirre**, R. Viana and M.A.F. Sanjuán, *Fractal structures in nonlinear dynamics*, Reviews of Modern Physics 81, 331-386 (2009). (Impact factor=33.145).

C.2. Congresses (brief selection of plenary/invited talks)

- *Network science to study the emergence of complexity in the origin of life,* Life and Space III Conference 2023, invited speaker, on line, 01-03/12/2023.
- *The emergence of interstellar molecular complexity explained by interacting networks,* European Astronomical Society Annual Meeting 2022, session "The Astrochemical Heritage: From molecular clouds to planetary surfaces", oral talk, Valencia, España, 27/06/2022.
- *NetWorld: A computational environment to simulate the prebiotic chemistry in the interstellar medium,* III BioinfoCAM meeting, oral talk, Madrid, 21/10/2021.
- *NetWorld: A computational environment to simulate the prebiotic chemistry in the interstellar medium,* EANA 2021 Conference (European Astrobiology Network Association), oral talk, Virtual Conference, 07/09/2021-10/09/2021.
- *Network science environment predicts transition towards complexity in prebiotic astrochemistry*, 10th International Conference on Complex Networks and Their Applications, plenary lightning talk, Universidad Politécnica de Madrid, 30/11/2021-2/12/2021.
- *Procesos de contagio desde la óptica de las redes complejas. ¿Soluciones para tomar decisiones hoy o en el futuro?*, MSD Health Innovation Forum 2020, invited speaker, Merck Sharp & Dohme España, S.A., Madrid, 14-20/09/2020.
- *Towards a theory of competition in evolutionary systems modeled as complex networks*, Minisymposium "Molecular Evolution and Fitness Landscapes" at "Modelling Biological Evolution 2017" Conference, invited speaker, University of Leicester, UK, 04-07/04/2017
- *Tipping points in the genetic composition of populations induced by environmental changes*, International Workshop on Genotype-Phenotype Maps, invited speaker, The Sainsbury Laboratory, University of Cambridge, UK, 08-09/09/2016.
- *Competition in evolutionary systems modeled as complex networks*, 2nd BCAM Workshop on Nonlinear dynamics in Biological Systems, invited speaker, Basque Center for Applied Mathematics, Bilbao, Spain, 01-02/09/2016
- *Tipping points in the genetic composition of populations induced by environmental stochasticity,* 1st BCAM Workshop on Nonlinear dynamics in Biological Systems, invited speaker, Basque Center for Applied Mathematics, Bilbao, Spain, 19-20/06/2014.

C.3. Research projects

As Principal investigator (see C.4 for PI in projects within the private sector):

Title: *Complex networks in interaction: Theory and astrobiological applications* (*NetWorld*).
Entity: MCIN. Plan Nacional de I+D+I. Reference PID2021-122936NB-I00.
Principal Investigator: Jacobo Aguirre and Raúl Guantes.
Number of researchers: 6.
Date: 01/09/2022-31/08/2025. **Total amount:** 36.300 €.

Title: *Ayudas para la realización de contratos para ayudantes de investigación y AYUDANTE DE INVESTIGACIÓN de la Comunidad de Madrid 2021.*
Entity: Comunidad de Madrid. Ref. PEJ-2021-AI/TIC-22450.
Number of researchers: 1.
Date: 30/01/2023-29/01/2025. **Total amount:** 45.000 €.

Title: Disipación, ruido y resonancia en dinámica no lineal. Referencia: PRE-2004-28.
Entity: Universidad Rey Juan Carlos
Principal Investigator: Jacobo Aguirre.
Number of researchers: 5
Date: 01/01/2005-30/09/2005**. Total amount:** 3.000 €.

As researcher (brief selection): 19 projects (7 *Plan Nacional de I+D+I*):

- **Title:** Dinámica No Lineal en sistemas biofísicos. **Entity:** MCIN. Convocatoria Redes de Investigación. Referencia RED2022-134573-T. **Principal Investigator**: Sergio Alonso. **Number of researchers**: 10. **Date:** 01/06/2023-31/05/2025**. Total amount:** 20.300 €.

- **Title:** Mecanismos microsópicos tras la evolución rápida: paisajes adaptativos, carreras de armas y redes de compartición de genes.
  Principal Investigator: Susanna Manrubia. **Number of researchers:** 5
  Entity: MINEICO. Plan Nacional de I+D+I. Reference FIS2017-89773-P.
  Date: 01/01/2018 – 31/12/2020. **Total amount:** 127050 €

- **Title:** Estrategias adaptativas en poblaciones virales. Hacia la identificación de clases de universalidad en evolución molecular.
  Principal Investigator: Susanna C. Manrubia. **Number of researchers:** 5
  Entity: MINECO. Plan Nacional de I+D+I. Reference FIS2014-57686.
  Date: 01/01/2015 – 31/12/2017**. Total amount:** 145.000 €

- **Title:** Evolución de poblaciones heterogéneas. Mecanismos de generación de diversidad y efectos del ambiente en la adaptación. Reference FIS2011-27569.
  Principal Investigator: Susanna C. Manrubia. **Number of researchers:** 9.
  Entity: MICINN and MINECO. Plan Nacional de I+D+I.
  Date: 01/01/2012-31/12/2014. **Total amount:** 220.200 €.

C.4. Contracts, technological or transfer merits

More than 10 research projects with private companies through *Complexity Killed the Cat SL*:
Responsibility: Principal Investigator. **Participating entities:** *Merck, Sharp & Dohme*, *Galderma*, *Zambon*, *PSL China*. **Date:** 2013-2021. **Total amount:** 75.000 €.
Main technological achievements: (1) Design and development of *PubNet*, a software to measure the scientific skills of Spanish medical doctors. **(2)** Development of a computational tool to analyse the professional informal networks of Spanish doctors (detection of key opinion leaders, rising stars, etc.)

Title: Technical services through the analysis of complex networks within the health area.
Responsibility: Coordinator of the total project.
Principal investigator: Juan Almendral Sánchez.
Participating entities: Merck Sharp & Dohme España, S.A., Universidad Rey Juan Carlos.
Financing entity: Merck Sharp & Dohme de España, S.A.
Date: 2010-2013, 3 years. **Total amount:** 35.950 €.

C.5. Organisation of scientific events

- **2020-23:** Programme committee of the *Complex Networks Conference*.
- **2020:** Organiser of the *Complex Networks Conference 2020*, Madrid.
- **2019:** Organiser of the *Workshop on Complex Networks in the Life Sciences*, Satellite Symposium of the *12th EBSA- 10th ICBP-IUPAP Biophysics Congress 2019*, Alcalá de Henares.
- **2018:** Organiser of the *15th Experimental Chaos and Complexity Conference*, Madrid.
- **2015:** Organiser of the *Workshop on Molecular Evolution and Fitness Landscapes*, Mini-symposium at the *Modelling Biological Evolution 2015 Conference*, University of Leicester, UK.
- **2014:** Organiser of the Mini-symposium *How do complex networks improve our knowledge of Biology?*, at the *10th AIMS Conference on Dynamical Systems, Differential Equations and Applications*, Madrid, Spain.
- **2013:** Organiser of the Mini-Symposium *Dynamical processes on complex networks*, at the *Dynamics Days 2013 Conference*, Madrid, Spain.
- **2010-2012:** Organiser of *Young Researcher's Day I, II and III*, Centro de Astrobiología, Madrid.